

Public Report ESA-043-3
FINAL

Company	Davisco Foods	ESA Dates	March 11 th to 13 th
Plant	Lake Norden, South Dakota	ESA Type	Steam
Product	Cheese & Dairy Products	ESA Specialist	Tom Tucker, P.E.

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:

On behalf of the Department of Energy, Tom Tucker of Kinergetics LLC conducted a steam system ESA at Davisco Foods in Lake Norden, South Dakota from March 11th to 13th, 2007. The ESA and training activities were provided through the United States Department of Energy-Save Energy Now initiative, which was begun to help the largest natural gas users in the United States identify ways to reduce energy use.

Steam System

There are three (3) gas fired boilers on site that were recently fitted with economizers. Saturated steam is generated at approximately 130-psig and reduced as needed to meet processing requirements. The annual average steam output was estimated at 27,100-pph over 8,760 hours per year.

Note: The difference in model estimated fuel cost may be due to a fewer number of run time hours at the average steam load of 27,100-pph.

The average efficiency of the boilers was estimated at 82-percent based on combustion testing and experience. This average “operating” efficiency includes skin losses and part load effects but does not include blowdown losses because they are automatically accounted for by SSAT. The blowdown rate was estimated at 4.5-percent based on conductivity data.

Objective of ESA:

The primary objective of the ESA was training on steam best practices and steam software tools since personnel from different facilities were present. This was the approach requested to facilitate project identification and evaluation after completion of the steam ESA.

Focus of Assessment:

Aside from the steam training discussions, the performance of the economizers and options for process heat recovery were reviewed. Anaerobic digestion was reviewed after the assessment but preliminary estimates indicate that the COD loading is insufficient for economic justification based on energy efficiency, even if the WWTP plant is modified to allow digestion of effluent directly from the plant.

Approach for ESA:

The ESA started with an introduction to the different steam tools and a number of common best practice measures. The Steam System Scoping Tool (SSST) was completed during the assessment. The facility scored approximately 81.8-percent. Scores above 75-percent are considered to be very good and scores below 55-percent indicate opportunity for improvement.

General Observations of Potential Opportunities:

Below are brief descriptions of each opportunity evaluated. Each opportunity has been rated based on the following definitions:

1. Near term opportunities: Include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.

2. Medium term opportunities: Require purchase of additional equipment and/or changes in the system such as addition of recuperative air pre-heaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
3. Long term opportunities: Require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

1. Reduce Steam Demand Reduction – Identify Use for Waste Heat to Evaporator Condenser

Based on design data taken from a drawing, there is approximately 5-MMBtu of vapor being sent to the condenser of the Perm evaporator. Even if only 50-percent of the vapor is recovered and used for heating, the estimated value is \$231,000 per year. A thermocompressor is probably the most effective means unless there is a need for low temperature water such as can be extracted from the condenser.

This opportunity is recommended for further investigation.

2. Reduce Steam Demand – Consider Condensing Heat Recovery to Preheat Dryer Inlet Air and Boiler Makeup Water

Condensing heat recovery (CHR) systems are designed to allow boiler exhaust to be cooled to a much lower temperature (90°F to 130°F) than is possible with a “standard” economizer such as those installed on the boilers. CHR works through recovery of the water vapor present in the exhaust from fuel combustion, which contains 8 to 10-percent of the fuel energy input to the boiler. The latent heat “held” by the water vapor is not available until the vapor begins to condense at approximately 135°F (stack temperatures from CHR systems commonly range from 90°F to 130°F). There is about 1-lb water vapor formed for each 10,000-Btu of gas burned.

Heat recovery from the spray dryer exhaust is being considered to preheat inlet spray dryer air. Based on preliminary analysis, assuming that the inlet air flow is 20,000-scfm, there is enough thermal demand to recover approximately 46-percent of the available heat compared to the maximum potential. The value of this heat is estimated at approximately \$130,000 annually based on a spray dryer efficiency of 65-percent.

Direct heat recovery from the dryer exhaust is another option that requires a bag filter to remove “stickies” to prevent plugging of the exchanger. The estimated value of this heat recovery option is approximately \$160,000 annually, again assuming a 65-percent spray dryer efficiency. This is being considered by the plant at present.

Either of these options will require significant capital to install, likely in the range of \$400,000 to \$600,000. In the event that it is desirable to explore condensing heat recovery, several suppliers are provided below for convenience but no endorsement of any particular supplier is implied.

- ESA (North Carolina): 800.680.4328
- Sidel Systems USA (California): 805.462.1250
- CHX (New York): 518.877.8805

Notes:

1. CHR will not compete with the standard economizers already installed.
2. If the CHR unit is sized to accept 100-percent of the exhaust flow, additional hot water loads can be added over time to help improve savings.
3. Recirculation loops between process dryers and the CHR unit can be used to preheat inlet air.
4. Water heating demands other than for dryer inlet air should be considered to increase overall savings. The maximum savings potential from CHR is on the order of \$216,000 per year.

3. Steam Demand Reduction – Recover Heat from Boiler Blowdown to Preheat Makeup/COW Water

The current boiler configuration does not include a blowdown heat recovery system to recover heat from automatic blowdown or continuous skimming. Typically these systems are used to preheat cold boiler makeup (city) water. However, there is very little city water used for boiler makeup. An alternative is to use the existing equipment to preheat hot COW water.

Preliminary engineering review of the existing process heat exchanger indicates that it is large enough to provide very good thermal performance. Discussion with the manufacturer indicate a shell design of 100-psig at 250°F and a tube

design of 150-psig at 400°F. Assuming correct data was provided by the manufacturer and that the mechanical integrity of the unit is good, the heat exchanger should work quite well for blowdown service.

The average rate of boiler blowdown appears to be approximately 4.5-percent based on conductivity data. At the estimated average steam rate of 27,100-pph, the average blowdown flow is 1,279-pph. Analysis indicates that the existing should preheat the makeup water from 145°F to about 161°F. This provides heat recovery of 254,800-Btu/hr.

This opportunity is recommended for consideration. All three boilers can be connected to a single recovery system. The simple return is expected to be on the order of 1-year.

Notes:

1. Another potential savings is water use reduction because city water is used to cool the hot blowdown, usually to 120°F, before it enters the sewer drain.
2. The design must include recirculation of the makeup water through the exchanger to prevent mineral scaling of the cold side tube surfaces.
3. Generally, the blowdown flow should be piped to the tube side.

4. Boiler Efficiency Improvement – Tune Boiler on at Least Twice per Year or Consider Oxygen Trim

Based on review of the combustion test data collected during the assessment tuning will likely provide some efficiency gain although it appears that the gain will be limited because the exhaust oxygen was already low. The #3 boiler has drifted furthest from the recent tune up in September 2007.

A ½-percent gain is assumed reasonable over all operating hours and will save approximately \$13,000 per year using the data collected during the assessment as the base case.

Tuning is normally inexpensive, but due to the plant location is relatively expensive. Options are to purchase a combustion analyzer and tune the boiler regularly (quarterly if possible) or install oxygen trim controls if low exhaust oxygen can be realized at the lower turndown ratios the boilers normally operate over.

The simple return will range from 6 months to 4.5-years depending on the options chosen.

Notes:

1. The cost savings estimate assumes that tuning will maintain the efficiency over the entire year. Present practice is to perform boiler tuning once per year and this is not sufficient to meet the estimated cost savings. Rather, two times per year is recommended at a minimum, during the time when seasonal changes occur. As discussed during assessment, quarterly tuning would be ideal.

5. Use Removable Insulation on 8-inch valves in Boiler House

With natural gas prices in the range of \$8.00/MMBtu any steam pipe 1-inch in diameter should be insulated, as well as valves, regulators and shell and tube exchangers with steam on the shell side.

The table below was developed from a “Fact Sheet” provided by the Depart of Energy concerning the cost of not insulating valves with removable insulation 2-inches thick. This insulation can be removed for easy maintenance and while it does cost more per foot, it is still cost effective at providing simple returns on the order of 1-year.

Table 3

Pressure	Temperature	Energy Savings (Btu/hr) based on valve size						
		2	3	4	6	8	10	12
psig	F							
55	300	2,420	3,630	4,340	6,500	8,670	10,300	13,010
230	400	4,173	6,260	7,470	11,210	14,940	17,750	22,420
130	356	3,402	5,103	6,093	9,138	12,181	14,472	18,280

There were six (6) eight-inch steam valves identified in the boiler house where removable insulate can be applied. Applying removable insulation to an eight-inch valve at 130-psig (steam) will save approximately 12,181-Btu/hr.

The cost of the blankets is estimated at \$600 each for a total of \$3,600, providing a simple return of less than one year.

A few suppliers are provided below for convenience but no endorsement of any particular supplier is implied.

- B&B insulation: 920.733.6086
- Advance Thermal Corporation: 630.595.5150
- Coverflex Manufacturing: 713.378.0966

6. Steam Demand Reduction – Lower DA Tank Pressure to Improve Economizer Performance

At the start of the assessment the DA tank was operating at approximately 9-psig (237°F). Lower pressures are often possible as long as the DA tank still provides effective removal of dissolved gasses, with 3-psig being a reasonable lower limit (223°F). The advantage of lowering the DA pressure in this case is that there will be lower water temperature water to the economizers. A lower water temperature will increase the temperature difference between the boiler exhaust and incoming water and thus the amount of exhaust heat removed.

Based on average operating conditions, lowering the DA pressure from 9-psig to 3-psig will improve overall economizer efficiency from 1.26-percent to 1.42-percent. The return is immediate. This was implemented in part during the assessment.

Note:

1. Post assessment modeling confirmed site measurements that indicating that the economizers are not performing as well as would normally be expected. Typical gains are anywhere from 2 to 3-percent, while those installed are providing gains about 1.25-percent based on conditions before the DA pressure was changed. The manufacturer should be consulted to determine the cause.
2. The recommended minimum DA water temperature is 215°F (1-psig). Adequate pressure control is necessary to prevent a pressure too far below setpoint.

Management Support and Comments:

Generally, the initial feedback on the ESA was favorable. Overall, facility staff were engaged, helpful and interested.

DOE Contact at Plant/Company: (who DOE would contact for follow-up regarding progress in implementing ESA results...)

Plant Contact: Dave Kindt

Company Contact: David Bero